

# Ares I-X 30 Day Report



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*December 3, 2009*





# Post Flight Data Schedule

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◆ This is the 30day report based on initial assessment of preliminary data

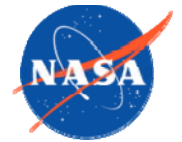
◆ **Future reports**

- |                 |               |
|-----------------|---------------|
| • 60 day report | Late January  |
| • 90 day report | Late February |



# Outline

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- ◆ **Ground Systems**
- ◆ **Guidance, Navigation and Control**
- ◆ **Roll Response**
- ◆ **Vehicle Response**
- ◆ **Control System Performance**
- ◆ **Structural Damping**
- ◆ **Thrust Oscillation**
- ◆ **Stage Separation**
- ◆ **Connector Assessment**
- ◆ **USS Splashdown**
- ◆ **Data Recorder**
- ◆ **FS Hardware Assessment**

# Ground Systems (GS)

- ◆ **Completely successful Fly Away Maneuver**
  - Designed to protect higher level structures
- ◆ **Minor damage was expected at lower levels**
  - Considered acceptable
  - Shuttle has routinely causes some damage
  - Plume impingement locations were different than Shuttle that had not been hardened yet



◆ **Also experienced some damage in the flame trench to the fondue fire.**

- West side wall had some damage on the flame fence wall. No obvious brick damage was observed.
- East wall damage was near a suspect location identified in the pre-launch inspection.





- ◆ PAD designers were very satisfied with results
- ◆ This flight will help Ares I structures designers as they design for an Ares I FAM





# Guidance, Navigation and Control

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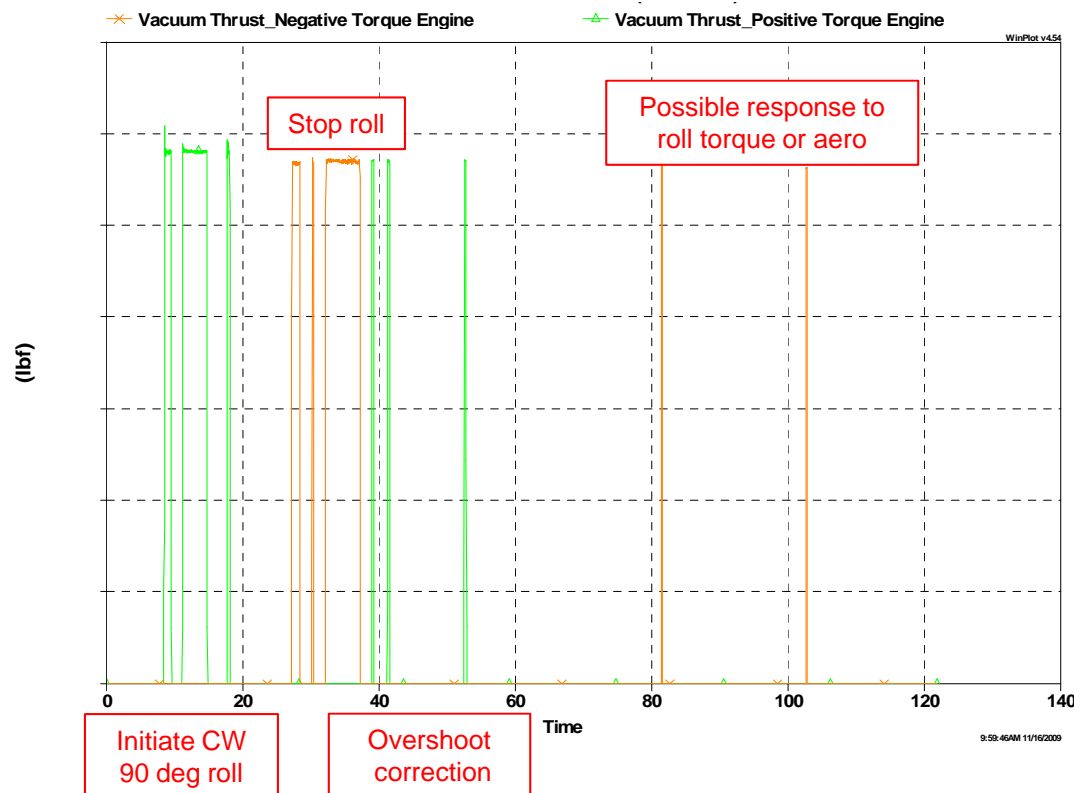


- ◆ **Preliminary lift off drift analysis shows the vehicle performed as expected.**
  - Aft Skirt location initially translates toward the FSS due to the Fly-Away Maneuver
  - Aft Skirt travels a very minimal amount toward the FSS
- ◆ **Vehicle bending response was as expected**

# Roll Torque Estimate

## ◆ Primary Objective 5 intended to estimate roll torque

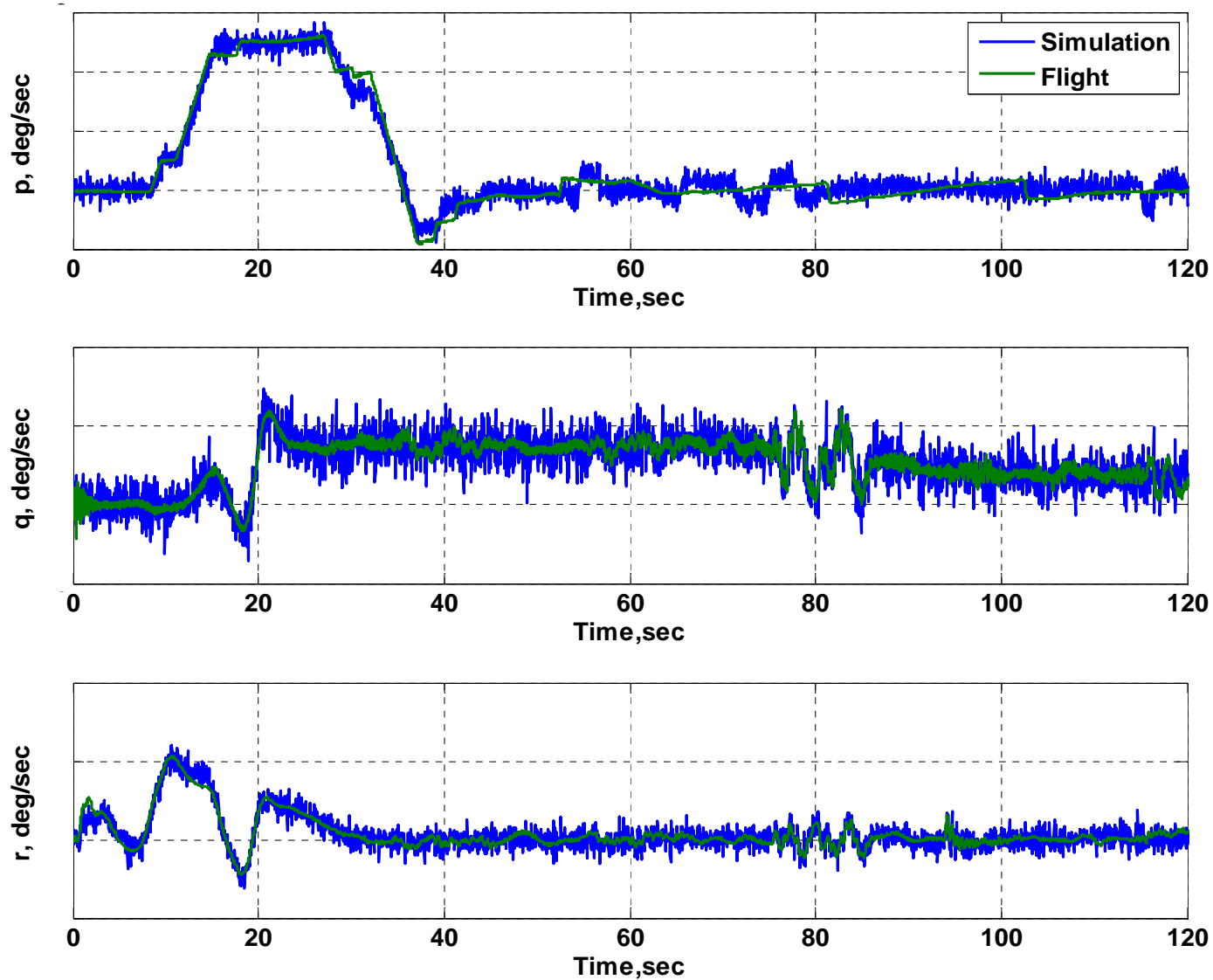
- Low roll torques observed
- Estimate of roll torque assessed by the Roll Control System firings
  - Very few firings required. Only a couple that may be related to roll torque
- Simulations show that roll torque may be primarily due to aero data as opposed to the motor





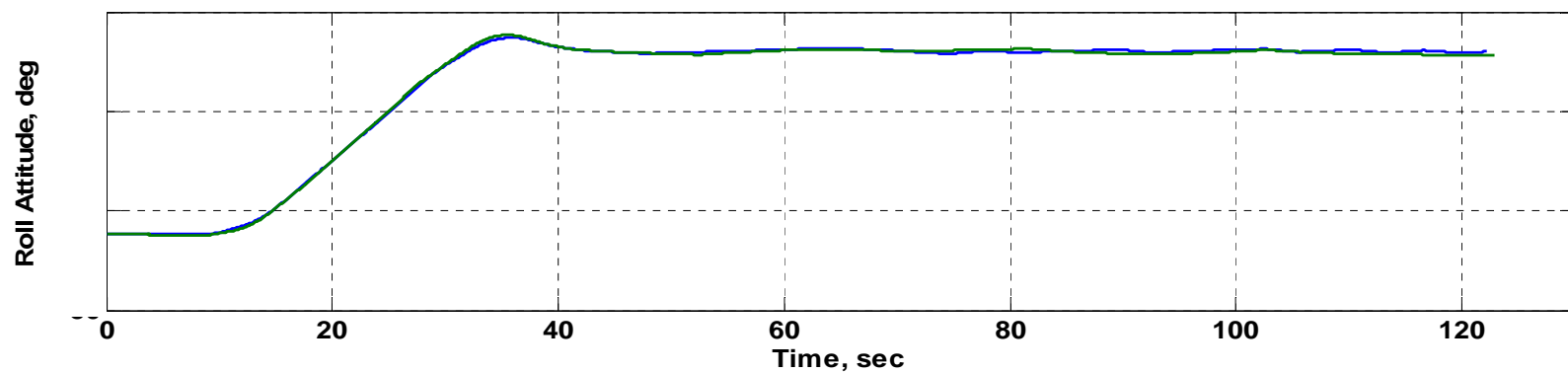
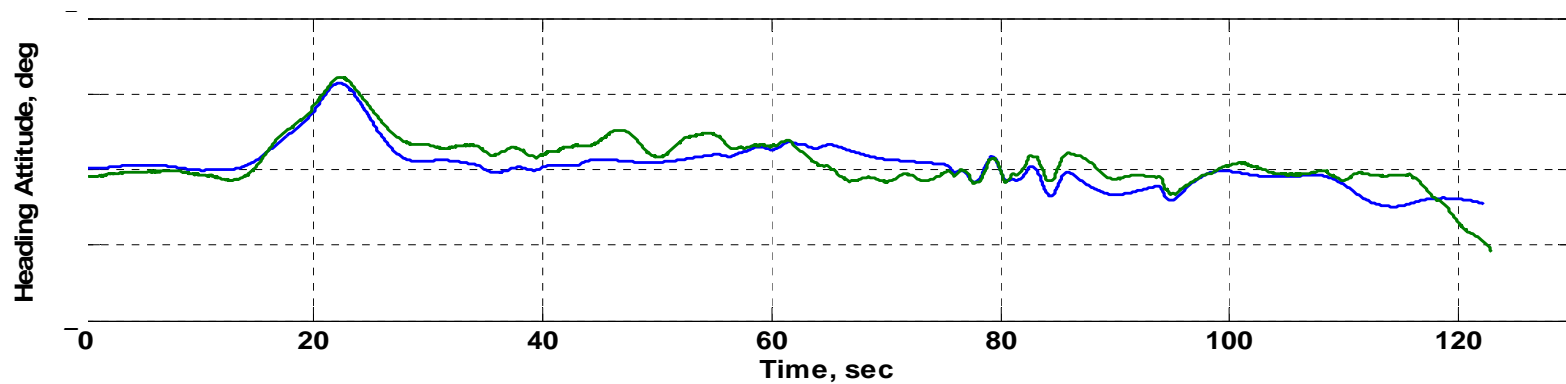
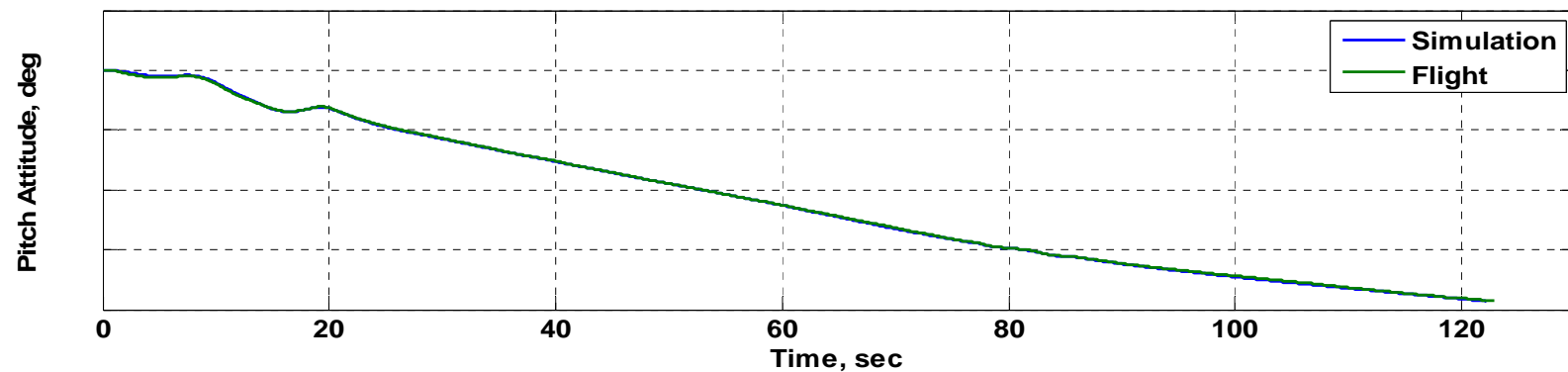


# Vehicle Response vs Simulation

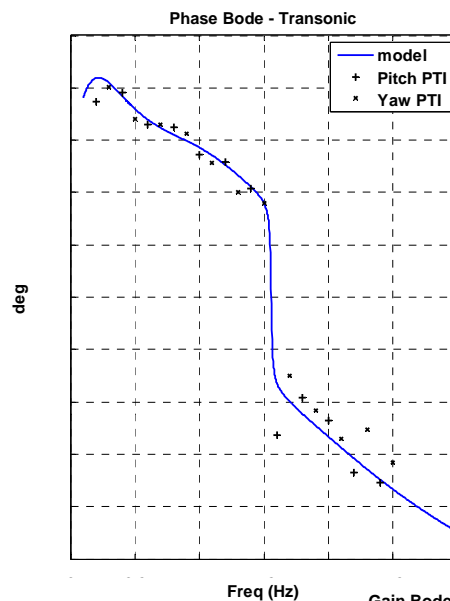
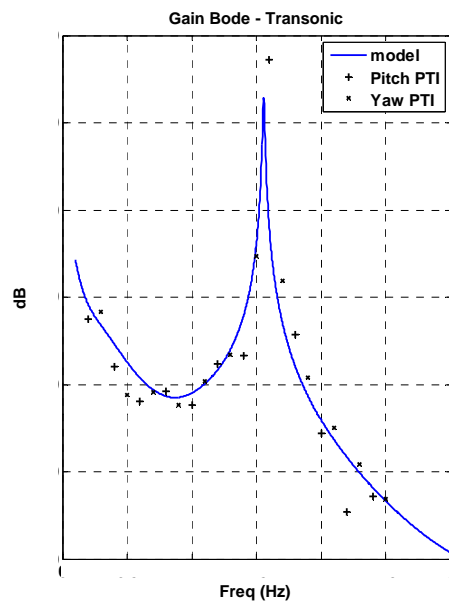




# Attitudes vs Simulation

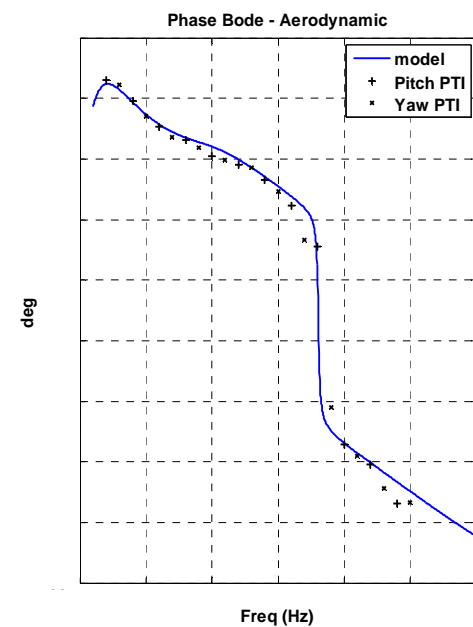
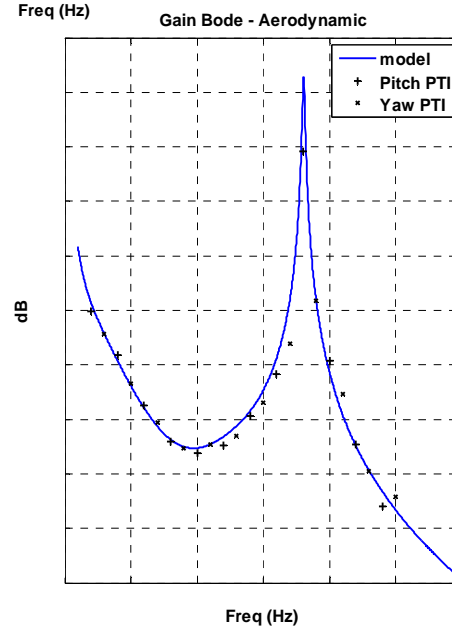


# Control System Performance

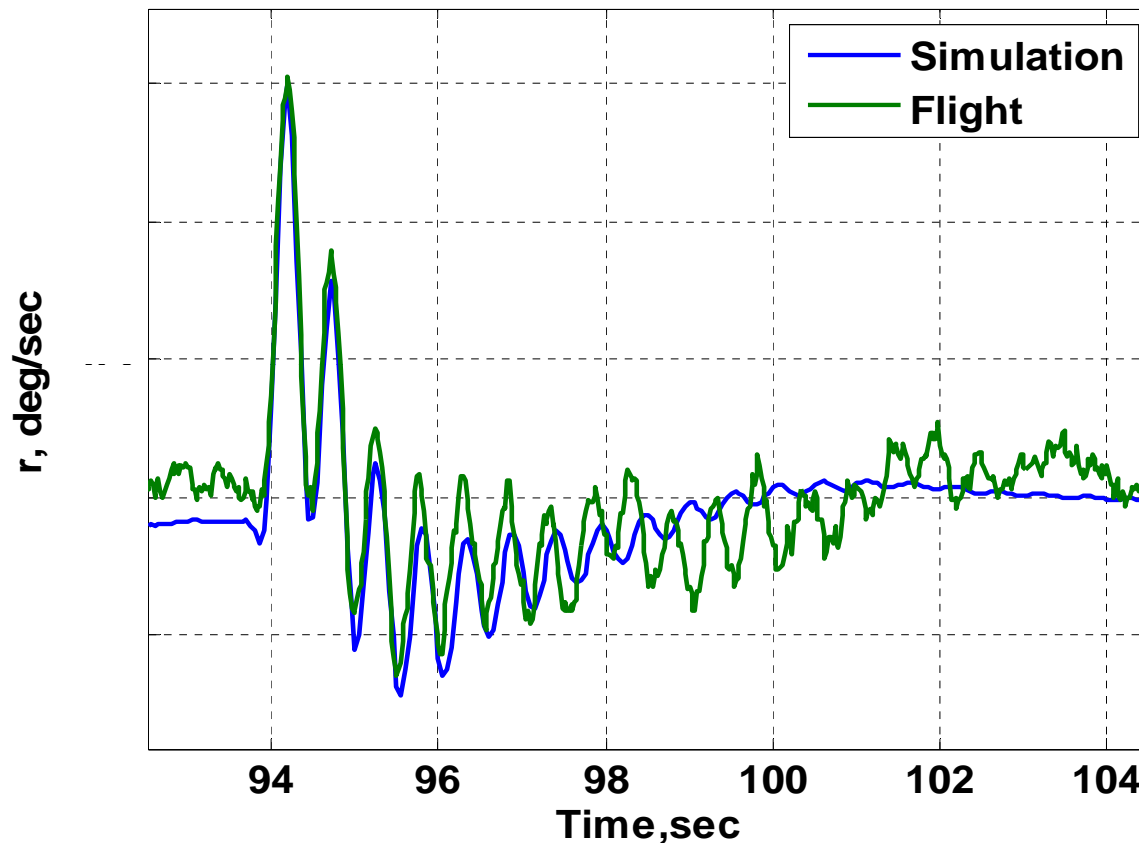


Transonic

Supersonic



# Structural Damping vs. Simulation



- ◆ Quick look shows closed-loop 1<sup>st</sup> mode flight damping about 20% lower than simulation.



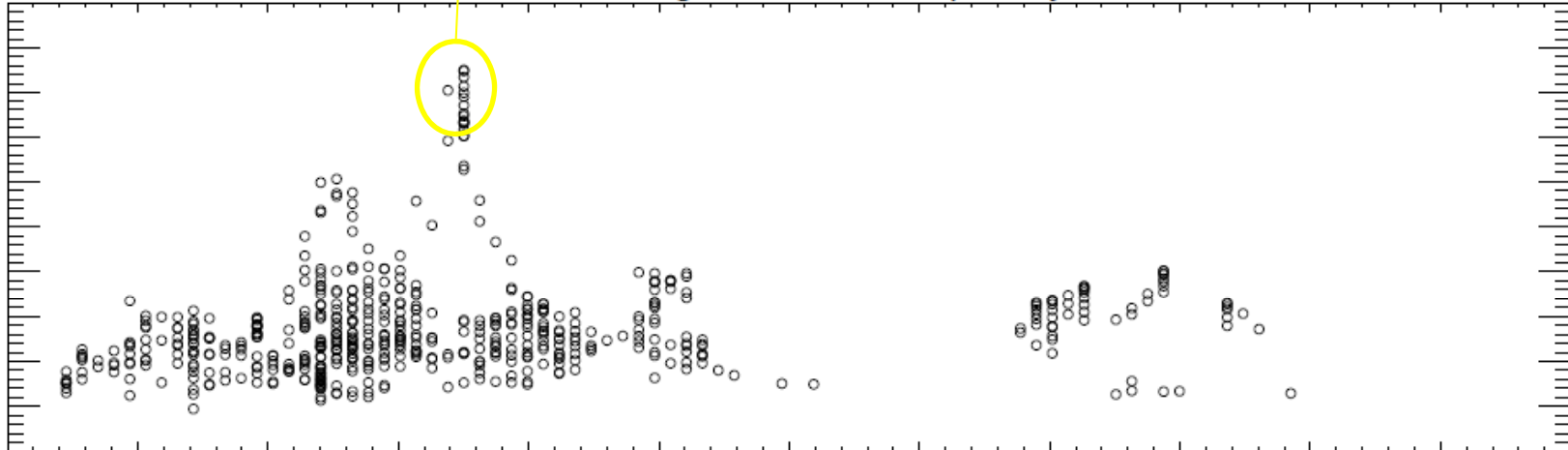
# First Thrust Oscillation Mode



- ◆ 1L thrust oscillation peaked between T+77 and T+79 seconds
- ◆ Substantial margin between recommended load and actual load
  - Peak pressure was about 1/3 of the predicted value
  - Frequency was ~15 Hz

77 to 79 seconds

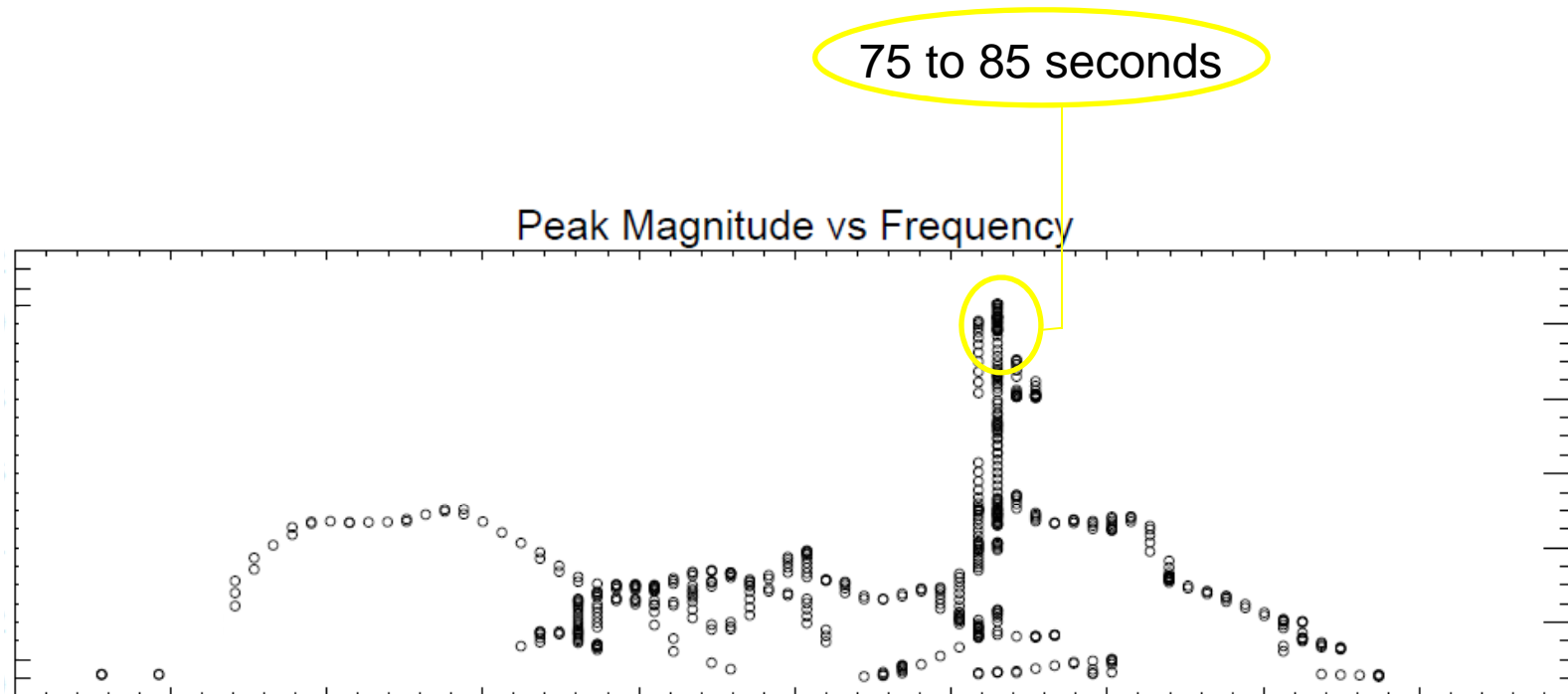
Peak Magnitude vs Frequency





## Second Thrust Oscillation Mode

- ◆ 2L thrust oscillation peaked between T+75 and T+85 seconds
- ◆ Substantial margin between recommended load and actual load
  - Peak pressure was about 1/2 of the predicted value
  - Frequency was ~ 29 Hz





# Nominal Stage Separation

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- ◆ **First Stage separation from the Upper Stage Separation was nominal**
  - Altitude at separation ~128 kft (nominal ~ 129 kft)
  - Mach ~4.6 (nominal 4.6)
- ◆ **No recontact**
  - Review of all the onboard and chase plane video show no indications of recontact
  - Initial review of debris radar does not indicate a recontact

# Forward Looking Video

Prior to Separation



Prior to Tumble



During Tumble



Partial First Turn



# Engineering Simulation of Separation

Separation + 3 Sec



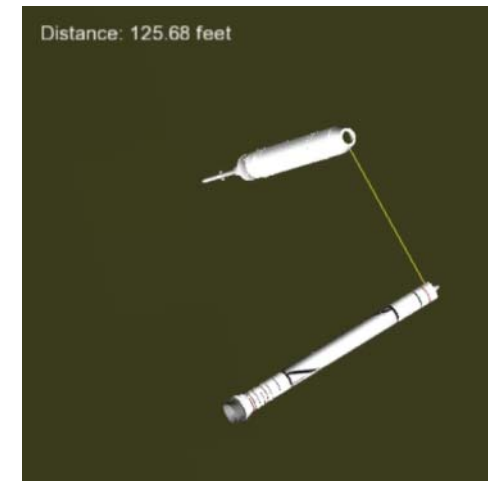
Separation + 5 Sec



Separation + 7 Sec



Separation + 9 Sec



- ◆ **Post-separation tumble of the Upper Stage Simulator was expected due to mass properties and aerodynamic forces**

# Connector Assessment

## ◆ Three separation connectors on the Forward Skirt dome did not separate

- Pendulum effect under the drogue chute may have caused an off center pull
- A improper disconnect failure scenario was identified prior to launch and determined not to have any significant effects to the system
- No loss of functionality of the connectors





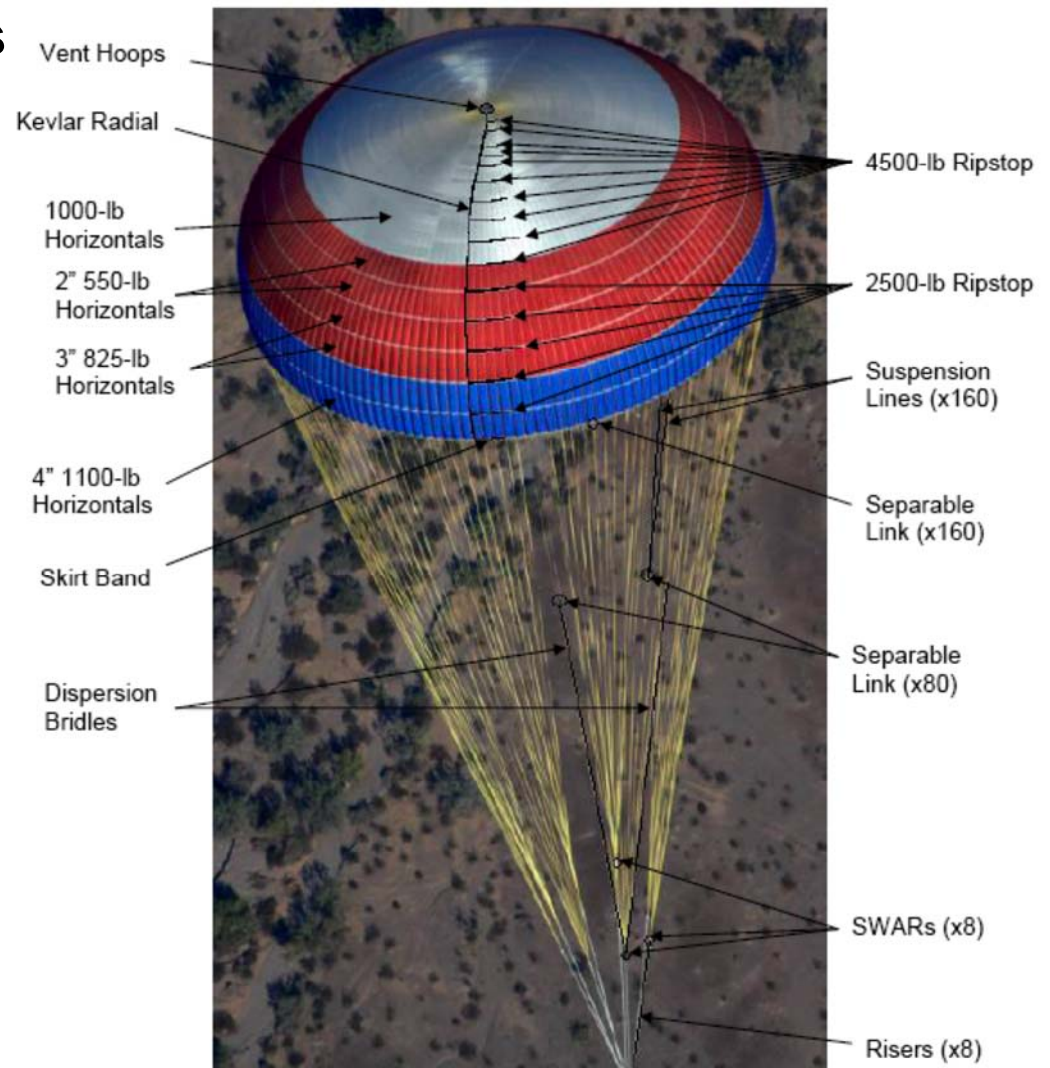
# Failed Separation Connectors



# Parachute Assessment

- ◆ One of the main parachutes failed at initial inflation
- ◆ 1<sup>st</sup> parachute may have “dis-reefed” prematurely allowing parachute to inflate too quickly
  - Increased initial load on parachute and riser line system
  - Salt Water Activation Release (SWAR) hardware exhibits damage representative of an overload
- ◆ A second parachute then partially failed
  - Assessment underway

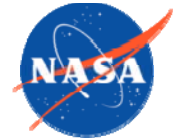
Major Components in a Main Parachute







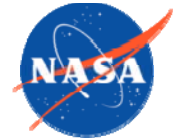
# Main Parachute Failure







# Main Parachute Failure





## Intact USS + CM/LAS prior to Splashdown

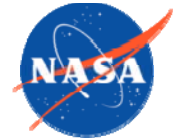






# Intact USS + CMLAS Splashdown

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# Data Delivery Status

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## ◆ Recovery of data from Data Recorder in process

- Completely recovered first 270 seconds of data and will be released internally by 12/8/09
  - Includes all 4 data streams and 3 video streams
- Remaining 80 seconds of data is still in work